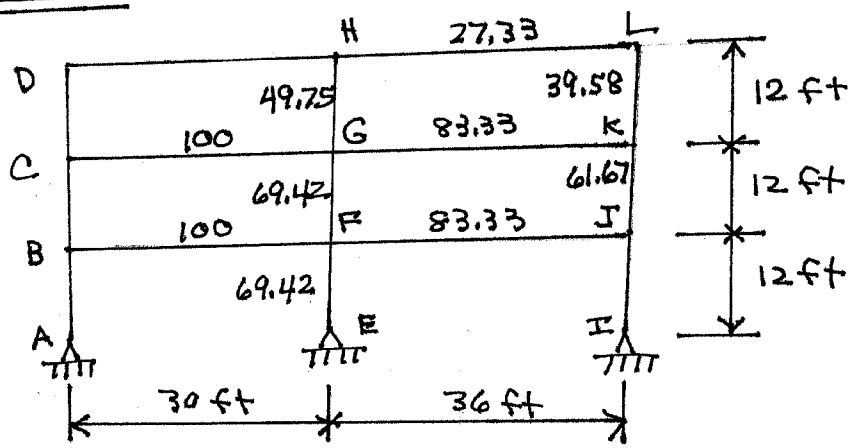
CHAPTER 7

PROB# 7-1

$\frac{I}{L}$ Values



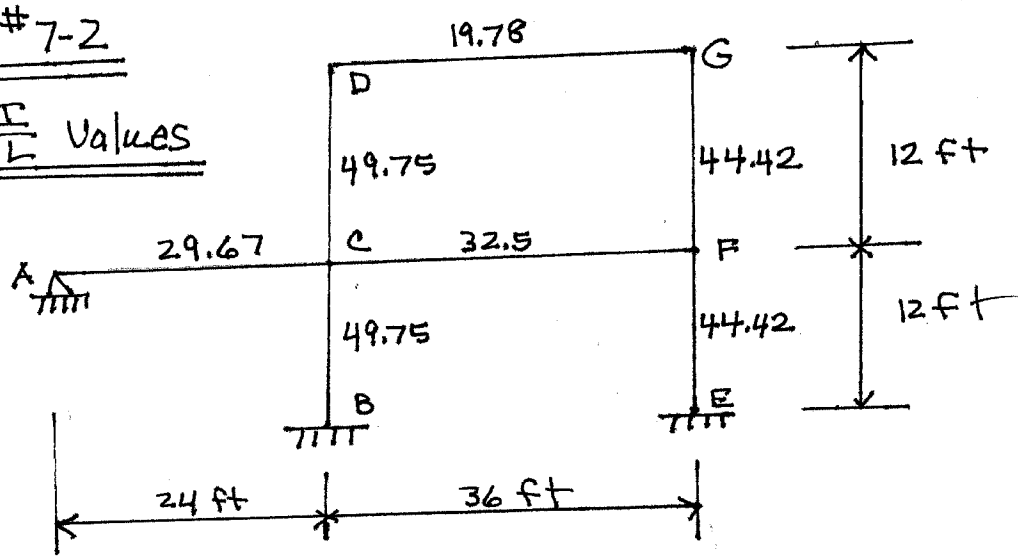
K Factors

COLUMN	G_A	G_B	K
EF	10.00	$\frac{(2)(69.42)}{183.33} = 0.76$	1.84
FG	$\frac{(2)(69.42)}{183.33} = 0.76$	$\frac{69.42+49.75}{183.33} = 0.65$	1.26
KL	$\frac{61.67+39.58}{83.33} = 1.22$	$\frac{39.58}{27.33} = 1.45$	1.44

VgcmS

PROB # 7-2

$\frac{I}{L}$ Values



K Factors

COLUMN	G_A	G_B	K
BC (no sidesway)	1.00	$\frac{(2)(49.75)}{29.67+32.5} = 1.60$	0.79
CD (sidesway)	$\frac{(2)(49.75)}{29.67+32.5} = 1.60$	$\frac{49.75}{19.78} = 2.52$	1.63
EF (no sidesway)	1.00	$\frac{44.42+44.42}{32.5} = 2.73$	0.83
FG (sidesway)	$\frac{(2)(44.42)}{32.5} = 2.73$	$\frac{44.42}{19.78} = 2.25$	1.73

PROB # 7-3

LRFD	ASD
$P_u = (1.2)(250) + (1.6)(500) = 1100\,k$	$P_a = 250 + 500 = 750\,k$

(a) Elastic Design

Beams are W21X68 ($I_x = 1480\ in.^4$)

Assume $KL = 14$ ft for Columns

Try W14 X 99 ($A = 29.1\ in.^2$, $I_x = 1110\ in.^4$, $\frac{r_x}{r_y} = 1.66$)

$$G_A = G_B = \frac{(2)\left(\frac{1110}{14}\right)}{(2)\left(\frac{1480}{28}\right)} = 1.50$$

$K = 1.48$ from sidesway uninhibited charts

Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}} = \frac{1.48 \times 14}{1.66} = 12.48$ ft

LRFD	ASD
USE W14X99 $\phi_c P_n = 1160\,k > 1100\,k$ ok	USE W14X99 $\frac{P_n}{\Omega_c} = 774\,k > 750\,k$ ok

(b) Inelastic Design

Try W14X90 ($A = 26.5\ in.^2$, $I_x = 999\ in.^4$, $\frac{r_x}{r_y} = 1.66$)

✓ jcm

PROB# 7-3 CONTD.

LRFD	ASD
$\frac{P_u}{A} = \frac{1100}{26.5} = 41.51$ ksi	$\frac{P_a}{A} = \frac{750}{26.5} = 28.30$ ksi
SRF from AISC Table 4-21 = 0.202	SRF from AISC Table 4-21 = 0.144
$G_A = G_B = \frac{(2)(\frac{999}{14})}{(2)(\frac{1480}{28})}(0.202)$	$G_A = G_B = \frac{(2)(\frac{999}{14})}{(2)(\frac{1480}{28})}(0.144)$
$= 0.273$	$= 0.194$
K from sidesway uninhibited charts = 1.08	K from sidesway uninhibited charts = 1.06
$K_x L_x = (1.08)(14) = 15.12$ ft	$K_x L_x = (1.06)(14) = 14.84$ ft
Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}}$	Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}}$
$= \frac{15.12}{1.66} = 9.11$ ft	$= \frac{14.84}{1.66} = 8.94$ ft
USE W14 X90	USE W14 X99

PROB# 7-4

LRFD	ASD
$P_u = (1.2)(300) + (1.6)(500) = 1160^k$	$P_a = 300 + 500 = 800^k$

(a) Elastic Design

Beams are W24X62 ($I_x = 1550\ in.^4$)

Assume $K = 1.4$ and $KL = (1.4)(14) = 19.6\ ft$

Try W12X136 ($A = 39.9\ in.^2$, $I_x = 1240\ in.^4$, $\frac{r_x}{r_y} = 1.77$)

Beams are W24 X62 ($I_x = 1550\ in.^4$)

$$G_A = G_B = \frac{(2)\left(\frac{933}{14}\right)}{(2)\left(\frac{1240}{28}\right)} = 1.50$$

$K_x = 1.47$ from sidesway uninhibited charts

$K_x L_x = (1.47)(14) = 20.58\ ft$

Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}} = \frac{20.58}{1.77} = 11.63\ ft$

LRFD	ASD
USE W12X106	USE W12X106
$\phi_c P_n = 1210^k$ (AISC Table 4-1)	$\frac{P_n}{\Omega_c} = 806^k$ (AISC Table 4-1)

PROB# 7-4 CONTD.

(b) Inelastic Design

Try W12x106 ($A = 31.2\ in.^2$, $I_x = 933\ in.^4$, $\frac{r_x}{r_y} = 1.76$)

LRFD	ASD
$\frac{P_u}{A} = \frac{1160}{31.2} = 37.18\ ksi$	$\frac{P_a}{A} = \frac{800}{31.2} = 25.64\ ksi$
SRF from Table 7-2 in text = 0.429	SRF from Table 7-2 in text = 0.361
$G_A = G_B = \frac{(2)(\frac{933}{14})}{(2)(\frac{1550}{28})}(0.429)$	$G_A = G_B = \frac{(2)(\frac{933}{14})}{(2)(\frac{1550}{28})}(0.361)$
$= 0.516$	$= 0.435$
K from sidesway uninhibited charts = 1.18	K from sidesway uninhib. charts = 1.16
$K_x L_x = (1.18)(14) = 16.52\ ft$	$K_x L_x = (1.16)(14) = 16.24\ ft$
Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}} = \frac{16.52}{1.76}$	Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}} = \frac{16.24}{1.76}$
$= 9.39\ ft$	$= 9.23\ ft$
USE W12x106	USE W12x106
$\phi_c P_n = 1272\ k > 1160\ k$ ok	$\frac{P_n}{\Omega_c} = 850\ k > 800\ k$ ok

✓ g.cm.c

PROB # 7-5

LRFD	ASD
$P_u = (1.2)(250) + (1.6)(500) = 1100$ k	$P_a = 250 + 500 = 750$ k

(a) Elastic Design

Beams are W24x62 ($I_x = 1550$ in.^{4})

Assume $KL = 14$ ft for Column

Try W12x106 ($A = 31.2$ in.^{2}, $I_x = 933$ in.^{4}, $\frac{\lambda_x}{\lambda_y} = 1.76$)

$$G_A = G_B = \frac{(2)\left(\frac{933}{14}\right)}{(2)\left(\frac{1550}{28}\right)} = 1.20$$

$K_x = 1.38$ from Sidesway Uninhibited Chart

$$(KL)_y \text{ equiv} = \frac{KL_x}{\frac{\lambda_x}{\lambda_y}} = \frac{(1.38)(14)}{1.76} = 11 \text{ ft}$$

LRFD	ASD
USE W12x96 $\phi_c P_n = 1110$ k > 1100 k ok	USE W12x106 $\frac{P_n}{\Omega_c} = 818$ k > 750 k

PROB# 7-5 CONTD

(b) Inelastic Design

LRFD	ASD
Try W12X96 ($A = 28.2\ in.^2$, $I_x = 833\ in.^4$, $\frac{r_x}{r_y} = 1.76$)	Try W12X96 ($A = 28.2\ in.^2$, $I_x = 833\ in.^4$, $\frac{r_x}{r_y} = 1.76$)
$\frac{P_u}{A} = \frac{1100}{28.2} = 39.006\ ksi$	$\frac{P_a}{A} = \frac{750}{28.2} = 26.602\ ksi$
SRF from AISC Table 4-21 $= 0.338$	SRF from AISC Table 4-21 $= 0.286$
$G_A = G_B = \frac{(2)(833)/14}{(2)(1480)/28}(0.338)$	$G_A = G_B = \frac{(2)(833)/14}{(2)(1480)/28}(0.286)$
$= 0.380$	$= 0.322$
K from sidesway uninhibited charts $= 1.12$	K from sidesway uninhibited charts $= 1.09$
$K_x L_x = (1.12)(14) = 15.68\ ft$	$K_x L_x = (1.09)(14) = 15.26\ ft$
Equiv. $K_y L_y = \frac{K_x L_x}{r_x/r_y}$	Equiv. $K_y L_y = \frac{K_x L_x}{r_x/r_y}$
$= \frac{15.68}{1.76} = 8.91\ ft$	$= \frac{15.26}{1.76} = 8.67\ ft$
USE W12X96	USE W12X96

✓ gcmc

PROB # 7-6

LRFD	ASD
$P_u = (1.2)(300)+(1.6)(600) = 1320$ k	$P_a = 300+600 = 900$ k

(a) Elastic Design

Beams are W30x99 ($I_x = 3990$ in.^{4})

Assume KL = 15 ft

Try W14x120 ($A = 35.3$ in.^{2}, $I_x = 1380$ in.^{4}, $\frac{r_x}{r_y} = 1.67$)

$$G_A = G_B = \frac{\frac{(2)(1380)}{15}}{\frac{(2)(3990)}{36}} = 0.83$$

$K = 1.27$ from sidesway uninhibited chart

$K_x L_x = (1.27)(15) = 19.05$ ft

Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}} = \frac{19.05}{1.67} = 11.41$ ft

LRFD	ASD
USE W14x120	USE W14x120
$\phi_c P_n = 1441.8$ k > 1320 k ok	$\frac{P_n}{\Omega_c} = 958.4$ k > 900 k ok

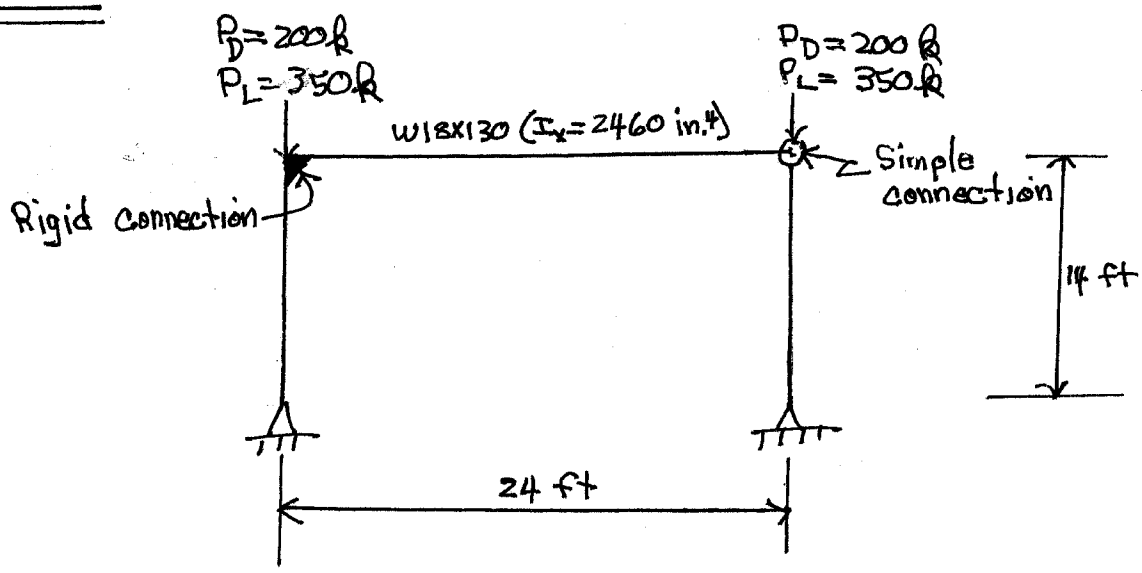
PROB #7-6 CONTD.

(b) Inelastic Design

LRFD	ASD
Try W14X109 ($A = 32.0\ in.^2$, $I_x = 1240\ in.^4$, $\frac{r_x}{r_y} = 1.67$)	Try W14X109 ($A = 32.0\ in.^2$, $I_x = 1240\ in.^4$, $\frac{r_x}{r_y} = 1.67$)
$\frac{P_u}{A} = \frac{1320}{32.0} = 41.25\ ksi$	$\frac{P_a}{A} = \frac{900}{32.0} = 28.12\ ksi$
SRF from AISC Table 4-21 $= 0.217$	SRF from AISC Table 4-21 $= 0.161$
$G_A = G_B = \frac{\frac{(2)(1240)}{15}}{\frac{(2)(3990)}{36}}(0.217)$	$G_A = G_B = \frac{\frac{(2)(1240)}{15}}{\frac{(2)(3990)}{36}}(0.161)$
$= 0.162$	$= 0.120$
K from sidesway uninhibited chart $= 1.04$	K from sidesway uninhibited chart $= 1.03$
$K_x L_x = (1.04)(15) = 15.6\ ft$	$K_x L_x = (1.03)(15) = 15.45\ ft$
Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}}$	Equiv. $K_y L_y = \frac{K_x L_x}{\frac{r_x}{r_y}}$
$= \frac{15.6}{1.67} = 9.34\ ft$	$= \frac{15.45}{1.67} = 9.25\ ft$
USE W14 X 109	USE W14 X109

✓ of CMS

PROB# 7-7



Design of right hand column with K=1.0 and KL= 14 ft

LRFD	ASD
P_u=(1.2)(200)+(1.6)(350)= 800 k From AISC Table 4-1 USE W14X90	P_a= 200 + 350 = 550 k From AISC Table 4-1 USE W14X90

PROB # 7-7 CONTD.

Design of left hand column

Try a section several sizes larger than the one selected for the right hand column. After a few trials

Try W14X159 ($A = 46.7\ in.^2$, $r_x = 6.38\ in.$, $I_x = 1900\ in.^4$)

G_A for bottom of left column $= 10$

G_B for top of left column $= \dfrac{\frac{1900}{14}}{\frac{2460}{24} \times 0.5} = 2.65$

0.5 used as sidesway is uninhibited and as far end of girder is pinned

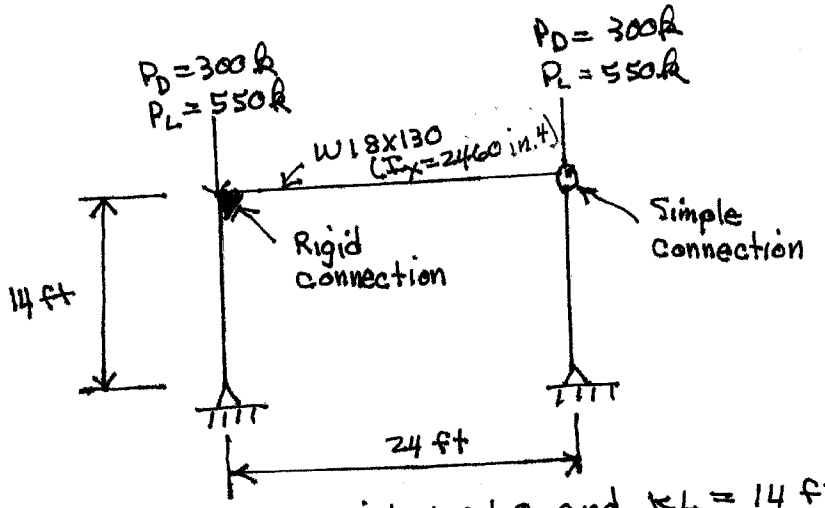
K_x from alignment chart Fig. 7.2(b) $= 2.30$

$\dfrac{K_x L_x}{r_x} = \dfrac{(2.30)(12 \times 14)}{6.38} = 60.56$

LRFD	ASD
$P_u = (2)(800) = 1600\ k$	$P_a = (2)(550) = 1100\ k$
$\phi_c F_{cr} = 34.43\ ksi$ from AISC Table 4-22	$\frac{F_{cr}}{\Omega_c}$ from AISC Table 4-22 $= 22.89\ ksi$
$\phi_c P_n = (34.43)(46.7) = 1608\ k$ $> (2)(800) = 1600\ k$ ok	$\frac{P_n}{\Omega_c} = (22.89)(46.7) = 1069\ k$ $< (2)(550) = 1100\ k$ N.G.
USE W14X159	USE W14X176

JCMC

PROB# 7-8



Design of Right Hand Column with K = 1.0 and KL = 14 ft

LRFD	ASD
$P_u = (1.2)(550)+(1.6)(300) = 1140$k USE W14X109	$P_a = 550 + 300 = 850$k USE W14X120

Design of Left Hand Column

Initially Assume K = 2.00 and KL = (2)(14) = 28 ft

LRFD	ASD
$P_u = (2)(1140) = 2280$k	$P_a = (2)(850) = 1700$k

PROB# 7-8 CONTD.

Try section several sizes larger than right hand column (or guess $K = 2.00$ or more and pick trial column).

After 1 or 2 trials Try W14X233 ($A = 68.5\ in.^2$, $I_x = 3010\ in.^4$, $r_x = 6.63\ in.$)

G_A for bottom of left column $= 10.0$

G_B for top of left column $= \dfrac{\frac{3010}{14}}{\frac{2460}{24} \times 0.5} = 4.20$

K from uninhibited alignment chart $= 2.42$

$\dfrac{K_x l_x}{r_x} = \dfrac{(2.42)(12 \times 14)}{6.63} = 61.32$

LRFD	ASD
$\phi_c F_{cr} = 34.20\ ksi$ $\phi_c P_n = (34.20)(68.5) = 2343^k$ $> 2280^k$ ok	$\dfrac{F_{cr}}{\Omega_c} = 22.74\ ksi$ $\dfrac{P_n}{\Omega_c} = (22.74)(68.5) = 1558^k$ $< 1700^k$ N.G.

ANSWERS W14X233 W14X257

vg cmc

PROB # 7-9

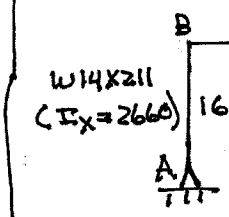
Design of center column

$KL = (1.0)(16) = 16$ ft

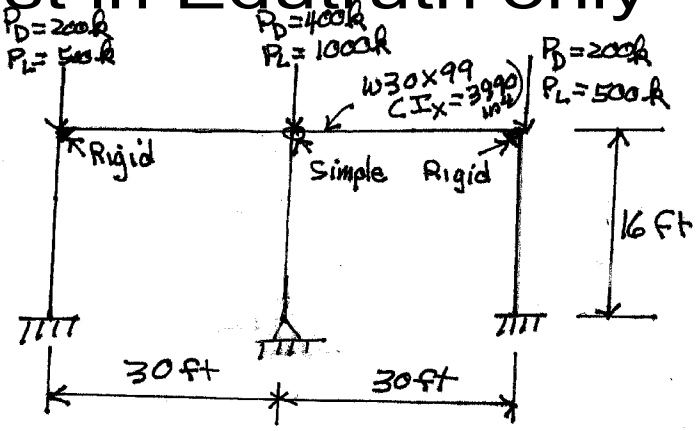
LRFD	ASD
$P_u = (1.2)(400) + (1.6)(1000) = 2080$ k From AISC Table 4-1 W14 X 193	$P_a = 400 + 1000 = 1400$ k From AISC Table 4-1 W14 X 193

Design of end columns

out of plane $K_y = 1.0$

LRFD	ASD
$P_u = (1.2)(200) + (1.6)(500) + (\frac{1}{2})(2080)$ $= 2080$ k Try W14 X 211 ($A = 62.0$ in.^{2}, $I_x = 2660$ in.^{4}, $r_x = 6.55$ in.)  $G_A = 10.00$ $G_B = \frac{2660/16}{(3990/30)X0.5} = 2.50$ K_x from uninhib. chart = 2.15 $\frac{K_x L_x}{r_x} = \frac{(2.15)(16)(12)}{6.55} = 63.02$ $\phi_c F_{cr} = 33.69$ ksi $\phi_c P_n = (33.69)(62.0) = 2089$ k > 2080 USE W14X211	$P_a = 200 + 500 + 200 + 500 = 1400$ k Try W14 X211 ($A = 62.9$ $I_x = 2669$ $r_x = 6.55$) Referring to figure to left $G_A = 10$ $G_B = \frac{2660/16}{(3990/30)(0.5)} = 2.50$ K_x from uninhib. chart $= 2.15$ $\frac{K_x L_x}{r_x} = \frac{(2.15)(12X16)}{6.55} = 63.02$ $\frac{F_{cr}}{\Omega_c} = 22.40$ ksi $\frac{P_n}{\Omega_c} = (22.40)(62.0)$ $= 1389$ k < 1400 k USE W14X233 ✓ JCMC

PROB # 7-10



Design of center column

KL=1 (16) =

LRFD	ASD
$P_u = (1.2)(400) + (1.6)(1000) = 2080$ k	$P_a = 400 + 1000 = 1400$ k
From AISC Table 4-1	From AISC Table 4-1
W14 X 176	W14 X 193

Design of exterior columns

Out of plane $K_y = 1.0$

LRFD	ASD
$P_u = (1.2)(200) + (1.6)(500) + (\frac{1}{2})(2080) = 2080$ k	$P_a = 200 + 500 + (\frac{1}{2})(1400) = 1400$ k
Try W14 X 176 ($A = 51.8$ in.^{2}, $I_x = 2140$, $r_x = 6.43$ in.)	Try W14 X 176 ($A = 51.8$ in.^{2}, $I_x = 2140$ in.^{4}, $r_x = 6.43$ in.)
$G_{Bottom} = 1.0$	$G_{Bottom} = 1.0$
$G_{Top} = \frac{2140/16}{(3990/30) \times 0.5} = 2.01$	$G_{Top} = \frac{2140/16}{(3990/30) \times 0.5} = 2.01$
K_y from uninhib. chart = 1.42	K_x from uninhib. chart = 1.42
$\frac{K_x L_x}{r_x} = \frac{(1.42)(12 \times 16)}{6.43} = 42.40$	$\frac{K_x L_x}{r_x} = \frac{(1.42)(12 \times 16)}{6.43} = 42.40$
$\phi_c F_{cr}$ from AISC Table 4-22 = 39.42 ksi	$\frac{F_{cr}}{\Omega_c} = 26.26$ ksi
$\phi_c P_n = (39.42)(51.8) = 2042 < 2080$ k	$\frac{P_n}{\Omega_c} = (26.26)(51.8) = 1360$ k < 1400 k N.G.
USE W14X193	USE W 14 X 193

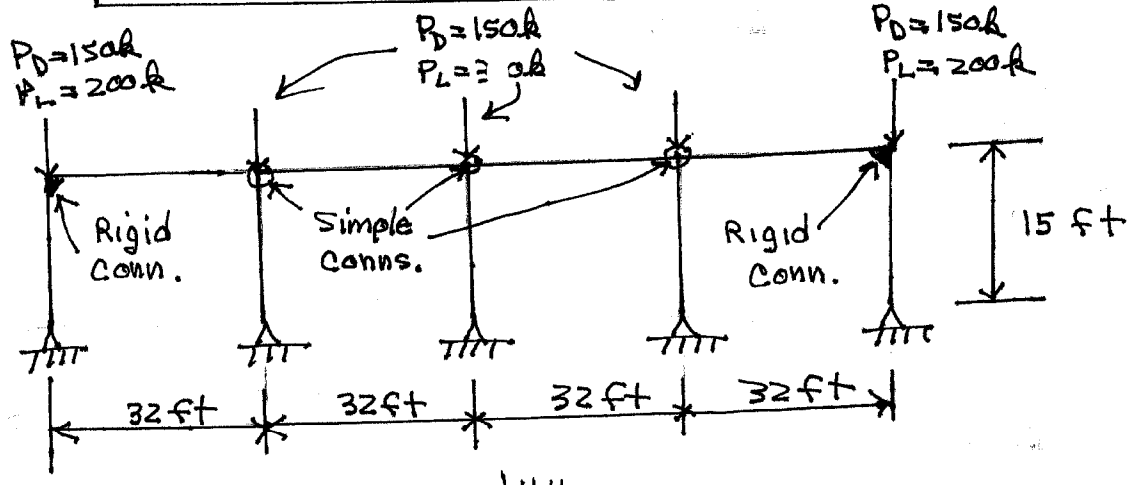
PROB # 7-11

Design of interior columns ($K=1.0$)

LRFD	ASD
$P_u=(1.2)(150)+(1.6)(350)=740$ k From AISC Table 4-1 with $KL=15$ ft USE W14x90	$P_a=150+350=500$ k From AISC Table 4-1 with $KL=15$ ft USE W14x90

Design of exterior columns

LRFD	ASD
$P_u=(1.2)(150)+(1.6)(200)+740+370=1610$ k Out of plane $K_y=1.0$ In plane $P_u=(1.2)(150)+(1.6)(200)=500$ k In plane K_x to be det. from alignment chart and $P_u=1610$ k	Out of plane $K_y=1.0$ $P_a=150+200=350$ k In plane K_x to be det. from alignment chart and $P_a=1100$ k



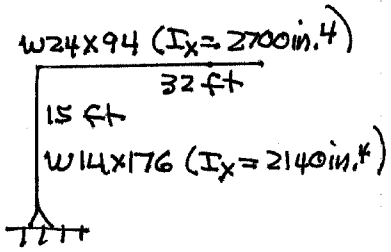
PROB #7-11 CONTD.

$$G_{top} = \frac{\frac{2140}{15}}{\frac{2700}{32} \times 0.5} = 3.38$$

$G_{Bottom} = 10$

$K_x = 2.34$ from chart

$$\frac{K_x L_x}{r_x} = \frac{(2.34)(12 \times 15)}{6.43} = 65.51$$



LRFD	ASD
$\phi_c F_{cr} = 32.85$ ksi	$\frac{F_{cr}}{\Omega_c} = 21.9$ ksi
$\phi_c P_n = (32.85)(51.8)$ = 1701.6 k > 1610 k ok	$\frac{P_n}{\Omega_c} = (21.9)(51.8)$ = 1134.4 k > 1100 k ok
USE W14X176	USE W14X176

Subsequent check of W14X159 shows it will not do for LRFD or ASD

✓ jcmc

PROB# 7-12

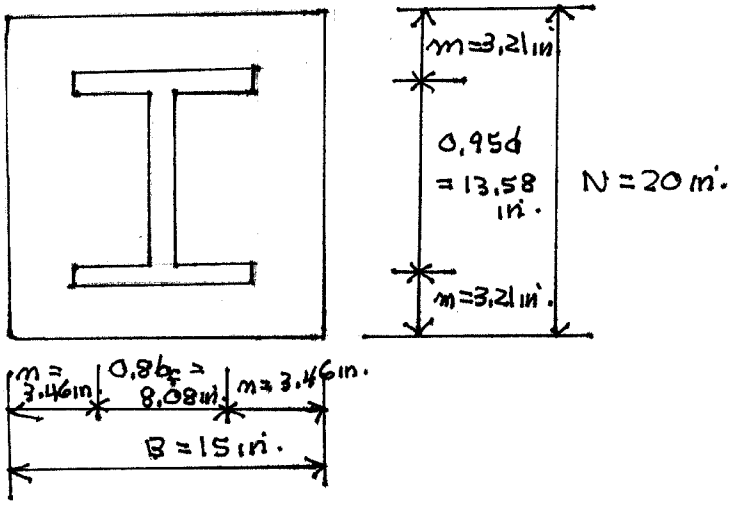
Using a W14x82 ($d = 14.3$ in., $b_f = 10.1$ in.)

LRFD	ASD
$P_u = (1.2)(120) + (1.6)(460) = 880$ k	$P_a = 120 + 460 = 580$ k
A_2 = ftg area $= (12 \times 11)(12 \times 11) = 17{,}424$ in.^{2}	$A_2 = (12 \times 11)(12 \times 11) = 17{,}424$ in.^{2}

Determine reqd. base plate area $= A_1 = BN$, Note that the area of the supporting concrete is far greater than the base plate area such that $\sqrt{\frac{A_2}{A_1}} \geq 2.0$.

LRFD $\phi_c = 0.60$	ASD $\Omega_c = 2.50$
$A_1 = \frac{P_u}{\phi_c (0.85 f'_c)\sqrt{A_2/A_1}}$	$A_1 = \frac{P_a \Omega_c}{0.85 f'_c \sqrt{A_2/A_1}}$
$= \frac{800}{(0.6)(0.85 \times 3)(2)} = 287.6$ in.^{2}	$= \frac{(580)(2.50)}{(0.85)(3)(2)} = 284.3$ in.^{2}

The base plate must be at least as large as the outside dimensions of the column $b_f d = (14.3)(10.1) = 144.4$ in.$^2 < 287.6$ in.^{2} and 284.3 in.^{2}. Optimizing base plate dimensions to make m and n in the following figure approximately equal.



PROB# 7-12 CONTD.

LRFD	ASD
$\Delta = \frac{0.95d - 0.8b_f}{2}$	$\Delta = \frac{0.95d - 0.8b_f}{2}$
$= \frac{(0.95)(14.3) - (0.8)(10.1)}{2} = 2.75$ in.	$= \frac{(0.95)(14.3) - (0.8)(10.1)}{2} = 2.75$ in.
$N = \sqrt{A_1} + \Delta = \sqrt{287.6} + 2.75 = 19.71$ in.	$N = \sqrt{A_1} + \Delta = \sqrt{284.3} + 2.75 = 19.61$ in.
$B = \frac{A_1}{N} = \frac{287.6}{19.71} = 14.59$ in.	$B = \frac{A_1}{N} = \frac{284.3}{19.61} = 14.50$ in.
USE PL 15X20	USE PL 15X20

Computing m, n and n' referring to the figure on the preceeding page

$$m = \frac{N - 0.95d}{2} = \frac{20 - (0.95)(14.3)}{2} = 3.21 \text{ in.}$$

$$n = \frac{B - 0.8b_f}{2} = \frac{15 - (0.8)(10.1)}{2} = 3.46 \text{ in.} \leftarrow$$

$$n' = \frac{\sqrt{db_f}}{4} = \frac{\sqrt{(14.3)(10.1)}}{4} = 3.00 \text{ in.}$$

Required base plate thickness

l = largest of m, n or $n' = 3.46$ in.

LRFD	ASD
$t_{reqd} = l\sqrt{\frac{2P_u}{0.9F_yBN}}$	$t_{reqd.} = l\sqrt{\frac{3.33P_a}{F_yBN}}$
$= 3.46\sqrt{\frac{(2)(880)}{(0.9)(36)(15)(20)}}$	$= 3.46\sqrt{\frac{(3.33)(580)}{(36)(15)(20)}}$
$= 1.47$ in.	$= 1.46$ in.

USE PL $1\frac{1}{2}$ X 15 X 1 ft 8 in. A36 FOR BOTH LRFD AND ASD

JCMS

PROB #7-13

Using a W12x106 ($d = 12.9$ in., $b_f = 12.2$ in.)

LRFD	ASD
$P_u = (1.2)(100) + (1.6)(420) = 792$ k	$P_a = 100 + 420 = 520$ k
$A_2 = (12x12)(12x12) = 20{,}736$ in.^{2}	$A_2 = (12x12)(12x12) = 20{,}736$ in.^{2}

Note that A_2 is many times larger than will be the base plate area. Thus $\sqrt{\frac{A_2}{A_1}} = 2$ max.

LRFD $\phi_c = 0.6$	ASD $\Omega_c = 2.50$
$A_1 = \frac{P_u}{\phi_c (0.85 f'_c)\sqrt{\frac{A_2}{A_1}}} = \frac{792}{(0.6)(0.85x4)(2)}$ $= 194.11$ in.^{2}	$A_1 = \frac{P_a \Omega_c}{0.85 f'_c \sqrt{\frac{A_2}{A_1}}} = \frac{(520)(2.5)}{(0.85)(4)(2)}$ $= 191.18$ in.^{2}

Base PL must be at least as large as $b_f d$ of the column $= (12.9)(12.2) = 157.38$ in.^{2} ok. Optimizing base plate dimensions to make m and n approximately equal.

LRFD	ASD
$\Delta = \frac{0.95d - 0.8 b_f}{2}$ $= \frac{(0.95)(12.9) - (0.8)(12.2)}{2}$ $= 1.25$ in.	$\Delta = \frac{0.95d - 0.8 b_f}{2}$ $= \frac{(0.95)(12.9) - (0.8)(12.2)}{2}$ $= 1.25$ in.
$N = \sqrt{A_1} + \Delta = \sqrt{194.11} + 1.25$ $= 15.18$ in.	$N = \sqrt{A_1} + \Delta = \sqrt{191.18} + 1.25$ $= 15.08$ in.
$B = \frac{A_1}{N} = \frac{194.11}{15.18} = 12.79$ in.	$B = \frac{A_1}{N} = \frac{191.18}{15.08} = 12.68$ in.
USE 13x16 PL	USE 13x16 PL

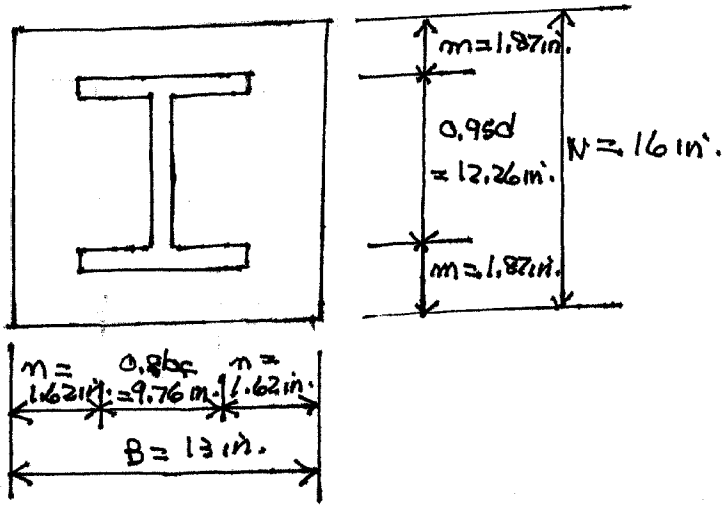
PROB # 7-13 CONTD.

Computing m, n and n' referring to following figure

$$m = \frac{N - 0.95d}{2} = \frac{16 - (0.95)(12.9)}{2} = 1.87 \text{ in.}$$

$$n = \frac{B - 0.8b_f}{2} = \frac{13 - (0.8)(12.2)}{2} = 1.62 \text{ in.}$$

$$n' = \frac{\sqrt{d b_f}}{4} = \frac{\sqrt{(12.9)(12.2)}}{4} = 3.14 \text{ in.} \Leftarrow$$



Reqd base plate thickness

l = largest of m, n or n' = 3.14 in.

LRFD	ASD
$t_{reqd} = l\sqrt{\frac{2P_u}{0.9F_y BN}}$	$t_{reqd} = l\sqrt{\frac{3.33P_a}{F_y BN}}$
$= 3.14\sqrt{\frac{(2)(792)}{(0.9)(36)(13)(16)}}$	$= 3.14\sqrt{\frac{(3.33)(520)}{(36)(13)(16)}}$
$= 1.52$ in.	$= 1.51$ in.

USE PL $1\frac{1}{2}$ x 13 x 1 ft 4 in A36 for Both LRFD and ASD

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PROB# 7-14

Using a W12x106 ($d = 12.9$ in., $b_f = 12.2$ in.)

LRFD	ASD
$P_u = (1.2)(100) + (1.6)(420) = 792$ k	$P_a = 100 + 420 = 520$ k
$A_2 = 28 \times 28 = 784$ in.^{2}	$A_2 = 28 \times 28 = 784$ in.^{2}

After some scratch work assume $\sqrt{\frac{A_2}{A_1}}$ = about 1.9

LRFD $\phi_c = 0.60$	ASD $\Omega_c = 2.50$
$A_1 = \frac{P_u}{\phi_c (0.85 f'_c)\sqrt{\frac{A_2}{A_1}}}$	$A_1 = \frac{P_a \Omega_c}{0.85 f'_c \sqrt{\frac{A_2}{A_1}}}$
$= \frac{792}{(0.6)(0.85 \times 4)(1.9)} = 204.3$ in.^{2}	$= \frac{(520)(2.5)}{(0.85)(4)(1.9)} = 201.2$ in.^{2}
Recalculating A_1	Recalculating A_1
$A_1 = \frac{792}{(0.6)(0.85 \times 4)\sqrt{\frac{784}{204.3}}} = 198.2$ in.^{2}	$A_1 = \frac{(520)(2.5)}{(0.85)(4)\sqrt{\frac{784}{201.2}}} = 193.6$ in.^{2}

The base plate must be at least as large as the column $= b_f d = (12.9)(12.2) = 157.4$ in.^{2} ok. optimizing plate dimensions to make m and n approx. equal.

LRFD	ASD
$\Delta = \frac{0.95d - 0.8 b_f}{2}$	$\Delta = \frac{0.95d - 0.8 b_f}{2}$
$= \frac{(0.95)(12.9) - (0.8 \times 12.2)}{2} = 1.25$ in.	$= \frac{(0.95)(12.9) - (0.8 \times 12.2)}{2}$
$N = \sqrt{A_1} + \Delta = \sqrt{198.2} + 1.25$	$= 1.25$ in.
$= 15.33$ in.	$N = \sqrt{A_1} + \Delta = \sqrt{193.6} + 1.25 = 15.16$ in.
$B = \frac{A_1}{N} = \frac{198.2}{15.33} = 12.93$ in.	$B = \frac{A_1}{N} = \frac{193.6}{15.16} = 12.77$ in.
USE 13x16 PL	USE 13 x 16 PL

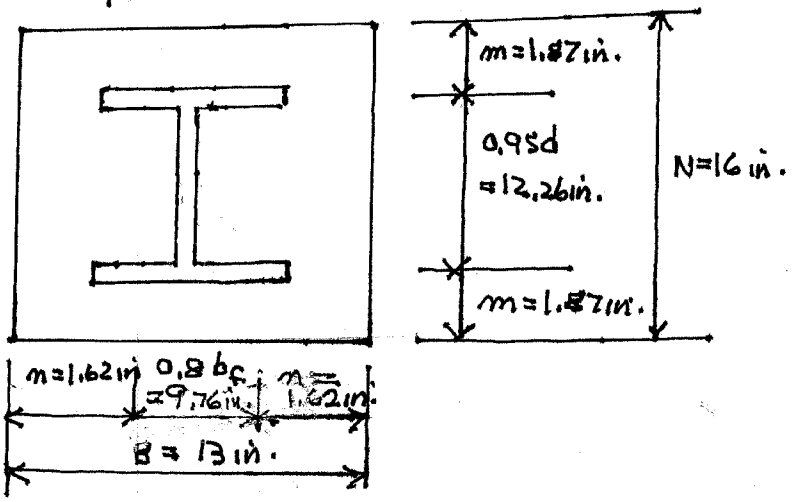
PROB # 7-14 CONTD.

Computing m, n and n' referring to following figure

$$m = \frac{N - 0.95d}{2} = \frac{16 - (0.95)(12.9)}{2} = 1.87 \text{ in.}$$

$$n = \frac{B - 0.8 b_f}{2} = \frac{13 - (0.8)(12.2)}{2} = 1.62 \text{ in.}$$

$$n' = \frac{\sqrt{d b_f}}{4} = \frac{\sqrt{(12.9)(12.2)}}{4} = 3.14 \text{ in.}$$



Required base plate thickness

ℓ = largest of m, n or n' = 3.14 in.

LRFD	ASD
$t_{reqd} = \ell\sqrt{\frac{2P_u}{0.9F_y BN}}$	$t_{reqd} = \ell\sqrt{\frac{3.33P_a}{F_y BN}}$
$= 3.14\sqrt{\frac{(2)(792)}{(0.9)(36)(13)(16)}}$	$= 3.14\sqrt{\frac{(3.33)(520)}{(36)(13)(16)}}$
$= 1.52$ in.	$= 1.51$ in.

USE PL $1\frac{1}{2}$ X 13 X 1 ft 4 in. A36
FOR BOTH LRFD AND ASD

PROB # 7-15

using a W14 x120 ($d = 14.5$ in., $b_f = 14.7$ in.)

LRFD	ASD
$P_u = (1.2)(150) + (1.6)(350) = 740$ k	$P_a = 150 + 350 = 500$ k
$A_2 = (12x10)(12x10) = 14{,}400$ in.^{2}	$A_2 = (12x10)(12x10) = 14{,}400$ in.^{2}

Note that A_2 is far greater than will be the base PL area. Thus $\sqrt{\frac{A_2}{A_1}} = 2$ max.

LRFD $\phi_c = 0.6$	ASD $\Omega_c = 2.5$
$A_1 = \frac{P_u}{\phi_c (0.85 f'_c) \sqrt{\frac{A_2}{A_1}}}$	$A_1 = \frac{P_a \cdot \Omega_c}{0.85 f'_c \sqrt{\frac{A_2}{A_1}}}$
$= \frac{740}{(0.6)(0.85x3)(2)} = 241.8$ in.^{2}	$= \frac{(500)(2.5)}{(0.85)(3)(2)} = 245.1$ in.^{2}

Base plate must be at least as large as $b_f d$ of the column $= (14.5)(14.7) = 213.15$ in.^{2}. OK. Optimizing base plate dimensions to make m and n approx. equal.

LRFD	ASD
$\Delta = \frac{0.95d - 0.8b_f}{2}$	$\Delta = \frac{0.95d - 0.8b_f}{2}$
$= \frac{(0.95)(14.5) - (0.8)(14.7)}{2} = 1.00$ in.	$= \frac{(0.95)(14.5) - (0.8)(14.7)}{2} = 1.00$ in.
$N = \sqrt{A_1} + \Delta = \sqrt{241.8} + 1.00 = 16.55$ in.	$N = \sqrt{A_1} + \Delta = \sqrt{245.1} + 1.00 = 16.66$ in.
$B = \frac{A_1}{N} = \frac{241.8}{16.55} = 14.61$ in.	$B = \frac{245.1}{16.66} = 14.71$ in.
USE 15x17 PL	USE 15x17 PL

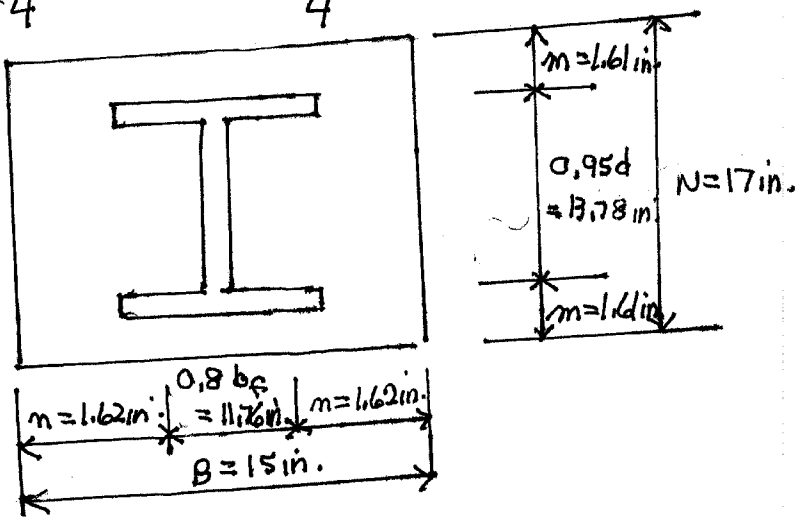
PROB# 7-15 CONT'D.

Computing m, n and n' referring to following figure

$$m = \frac{N - 0.95d}{2} = \frac{17 - (0.95)(14.5)}{2} = 1.61 \text{ in.}$$

$$n = \frac{B - 0.8\,b_f}{2} = \frac{15 - (0.8)(14.7)}{2} = 1.62 \text{ in.}$$

$$n' = \frac{\sqrt{d\,b_f}}{4} = \frac{\sqrt{(14.5)(14.3)}}{4} = 3.65 \text{ in.}$$



Required base plate thickness

ℓ = largest of m, n or $n' = 3.65$ in.

LRFD	ASD
$t_{reqd} = \ell\sqrt{\frac{2P_u}{0.9F_yBN}}$	$t_{reqd} = \ell\sqrt{\frac{3.33P_a}{F_yBN}}$
$= 3.65\sqrt{\frac{2 \times 740}{(0.9)(36)(15)(17)}}$	$= 3.65\sqrt{\frac{(3.33)(500)}{(36)(15)(17)}}$
$= 1.55$ in.	$= 1.55$

USE PL $1\frac{5}{8}$ x 15 x 1 ft 5 in. for both LRFD and ASD

✓ JCMC

PROB # 7-16

Using a W14 x 90 ($d = 14.0$ in., $b_f = 14.5$ in.)

LRFD $\phi_c = 0.60$	ASD $\Omega_c = 2.50$
$P_u = (1.2)(180) + (1.6)(560) = 1112$ k After some scratchwork assume $\sqrt{\frac{A_2}{A_1}} = 1.25$ Then $A_1 = \frac{P_u}{(0.6)(0.85 f'_c)\sqrt{\frac{A_2}{A_1}}}$ $= \frac{1112}{(0.6)(0.85)(3)(1.25)} = 581$ in.^{2} Say 24 x 24 ($A_1 = 576$ in.^{2}) Then $A_2 =$ 30 x 30 ($A_2 = 900$ in.^{2}) And $\sqrt{\frac{900}{576}} = 1.25$ ok	$P_a = 180 + 560 = 740$ k After some scratchwork assume $\sqrt{\frac{A_2}{A_1}} = 1.25$ Then $A_1 = \frac{P_a \Omega_c}{0.85 f'_c \sqrt{\frac{A_2}{A_1}}}$ $= \frac{(740)(2.5)}{(0.85)(3)(1.25)} = 580$ in.^{2} Say 24 x 24 ($A_1 = 576$ in.^{2}) Then $A_2 =$ 30 x 30 ($A_2 = 900$ in.^{2}) And $\sqrt{\frac{900}{576}} = 1.25$ ok

Base plate must be at least as large as $b_f d$ of the column $= (14.5)(14.0) = 203$ in.^{2} ok. Optimizing base plate dimensions to make m and n approx equal.

LRFD	ASD
$\Delta = \frac{0.95d - 0.8 b_f}{2}$ $= \frac{(0.95)(14.0) - (0.8)(14.5)}{2}$ $= 0.85$ in. $N = \sqrt{A_1} + \Delta = \sqrt{581} + 0.85 = 24.95$ in. $B = \frac{A_1}{N} = \frac{581}{24.95} = 23.29$ in. USE 24 x 24 PL	$\Delta = \frac{0.95d - 0.8 b_f}{2}$ $= \frac{(0.95)(14.0) - (0.8)(14.5)}{2}$ $= 0.85$ in. $N = \sqrt{A_1} + \Delta$ $= \sqrt{580} + 0.85 = 24.93$ in. $B = \frac{A_1}{N} = \frac{580}{24.93} = 23.27$ in. USE 24 x 24 PL

PROB # 7-16 CONTD,

Computing m, n and n'

$$m = \frac{N - 0.95d}{2} = \frac{24 - (0.95)(14.0)}{2} = 5.35 \text{ in.}$$

$$n = \frac{B - 0.8\, b_f}{2} = \frac{24 - (0.8)(14.5)}{2} = 6.2 \text{ in.} \leftarrow$$

$$n' = \frac{\sqrt{d b_f}}{4} = \frac{\sqrt{(14.0)(14.5)}}{4} = 3.56 \text{ in.}$$

ℓ = largest of m, n and $n' = 6.2$ in.

LRFD	ASD
$t_{reqd} = \ell \sqrt{\frac{2P_u}{0.9 F_y B N}}$	$t_{reqd} = \ell \sqrt{\frac{3.33 P_a}{F_y B N}}$
$= 6.2 \sqrt{\frac{(2)(1112)}{(0.9)(36)(24)(24)}}$	$= 6.2 \sqrt{\frac{(3.33)(740)}{(36)(24)(24)}}$
$= 2.14$ in.	$= 2.14$ in.

USE PL $2\frac{1}{4}$ X 24 X 2ft 0 in. for both LRFD And ASD

VJCM